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RESEARCH MEMORANDUM

LIFT, DRAG, AND PITCHING MOMENT OF LOW-ASPECT-RATIO WINGS AT
SUBSONIC AND SUPERSONIC SPEEDS - TWISTED AND CAMBERED
TRIANGULAR WING OF ASPECT RATIO 2 WITH NACA 0005-63
THICKNESS DISTRIBUTION

By John C. Heitmeyer and Robert B. Petersen

Ames Aeronautical Laboratory
Moffett Field, Calif.

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SUMMARY

This report presents the results of a wind-tunnel investigation at subsonic and supersonic Mach numbers to determine the aerodynamic characteristics of a wing-body combination having a triangular wing of aspect ratio 2. The mean surface of the wing was twisted and cambered to support a nearly elliptical span load distribution at a Mach number of 1.53 and a lift coefficient of 0.25. The NACA 0005-63 thickness distribution was used in combination with the theoretically determined mean lines to derive the streamwise airfoil sections.

The lift, drag, and pitching moment of the model are presented for Mach numbers from 0.60 to 0.90 and from 1.30 to 1.90 at Reynolds numbers of 3.0, 4.9, and 7.5 million. (At a Reynolds number of 7.5 million, wind-tunnel power limited the maximum test Mach number to 1.70.)

INTRODUCTION

A research program is in progress at the Ames Aeronautical Laboratory to ascertain experimentally at subsonic and supersonic Mach numbers the characteristics of wings of interest in the design of high-speed fighter airplanes. The effects of variations in plan form, twist, camber, and thickness are being investigated. This report is one of a series pertaining to this program and presents results of tests of a wing-body combination having a triangular wing of aspect ratio 2 with NACA 0005-63 thickness distribution in streamwise planes, and twisted and cambered to support a nearly elliptical spanwise loading at the design conditions. Results of other investigations in this program are presented in references 1 to 13. As in these references, the data herein are presented without analysis to expedite publication.

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NOTATION

b	wing span
\bar{c}	mean aerodynamic chord $\left(\frac{\int_0^{b/2} c^2 dy}{\int_0^{b/2} c dy} \right)$
c	local wing chord projected in the wing reference plane ¹
l	length of body including portion removed to accommodate sting
$\frac{L}{D}$	lift-drag ratio
$\left(\frac{L}{D} \right)_{\max}$	maximum lift-drag ratio
M	Mach number
q	free-stream dynamic pressure
R	Reynolds number based on mean aerodynamic chord
r	radius of body
r ₀	maximum body radius
S	total wing area projected in wing reference plane, ¹ including area enclosed by body
x	longitudinal distance from nose of body
X	longitudinal distance from wing leading edge, measured in wing reference plane ¹
y	lateral distance from plane of symmetry
Z	vertical distance from wing reference plane ¹
α	angle of attack of the body axis, degrees
C _D	drag coefficient $\left(\frac{\text{drag}}{qS} \right)$
C _L	lift coefficient $\left(\frac{\text{lift}}{qS} \right)$

¹Wing reference plane is defined as the plane perpendicular to the plane of symmetry and containing the wing chord in the plane of symmetry.

C_m pitching-moment coefficient about the 25-percent position of the wing mean aerodynamic chord $\left(\frac{\text{pitching moment}}{qS\bar{c}} \right)$

$\frac{dC_L}{d\alpha}$ slope of the lift curve measured at zero lift, per degree

$\frac{dC_m}{dC_L}$ slope of the pitching-moment curve measured at zero lift

Subscripts

U upper surface of wing

L lower surface of wing

APPARATUS

Wind Tunnel and Equipment

The experimental investigation was conducted in the Ames 6- by 6-foot supersonic wind tunnel. In this wind tunnel, the Mach number can be varied continuously and the stagnation pressure regulated to maintain a given test Reynolds number. The air is dried to prevent formation of condensation shocks. Further information on this wind tunnel is presented in reference 14.

The model was sting mounted in the wind tunnel, the diameter of the sting being about 73 percent of the diameter of the body base. The pitch plane of the model support was horizontal. The 4-inch diameter, 4-component, strain-gage balance, described in reference 15, was enclosed within the body of the model and was used to measure the aerodynamic forces and moments.

Model

The mean surface of the wing of the present investigation was twisted and cambered to support a nearly elliptical span load distribution at a Mach number of 1.53 at a lift coefficient of 0.25. The theoretical development of this particular mean surface is presented in reference 8. An NACA 0005-63 airfoil section was used as the thickness distribution in combination with the mean lines to make up the streamwise airfoil sections. The streamwise section coordinates for this wing are given in table I.

A plan view of the model and certain model dimensions are given in figure 1. Other important geometric characteristics of the model are as follows:

Wing

Aspect ratio	2
Taper ratio.	0
Total area, S, square feet	4.014
Mean aerodynamic chord, \bar{c} , feet	1.888
Incidence, degrees	0
Distance, wing reference plane to body axis, feet	0

Body

Fineness ratio (based upon length, l , fig. 1)	12.5
Cross-section shape	Circular
Maximum cross-sectional area, square feet	0.204
Ratio of maximum cross-sectional area to wing area	0.0509

The body spar was steel and was covered with aluminum to form the body contours. The wing of the model of reference 8 was covered with tin-bismuth alloy to form the contours of the wing of the present investigation. The surfaces of the wing and body were polished smooth.

TESTS AND PROCEDURE

Range of Test Variables

The aerodynamic characteristics of the model (as a function of angle of attack) were investigated for a range of Mach numbers from 0.60 to 0.90 and from 1.30 to 1.90 at Reynolds numbers of 3.0, 4.9, and 7.5 million. (Tests at a Reynolds number of 7.5 million were limited to a maximum test Mach number of 1.70 because of wind-tunnel-power limitations.)

Reduction of Data

The test data have been reduced to standard NACA coefficient form. Factors which affect the accuracy of these results, together with the corrections applied, are discussed in the following paragraphs.

Tunnel-wall interference.— Corrections to the subsonic results for the induced effects of the tunnel walls resulting from lift on the model were made according to the methods of reference 16. The numerical values

of these corrections (which were added to the uncorrected data) were obtained from

$$\Delta\alpha = 0.93 C_L$$

$$\Delta C_D = 0.016 C_L^2$$

No corrections were made to the pitching-moment coefficients.

The effects of constriction of the flow at subsonic speeds by the tunnel walls were taken into account by the method of reference 17. This correction was calculated for conditions at zero angle of attack and was applied throughout the angle-of-attack range. At a Mach number of 0.90, this correction amounted to a 5-percent increase in the Mach number and in the dynamic pressure over that determined from a calibration of the wind tunnel without a model in place.

For the tests at supersonic speeds, the reflection from the tunnel walls of the Mach wave originating at the nose of the body did not cross the model. No corrections were required, therefore, for tunnel-wall effects.

Stream variations. - Tests of a symmetrical model at subsonic speeds in both the normal and the inverted positions have indicated a slight stream inclination and curvature in the pitch plane of the model. Results of these tests indicate that a -0.07° stream angle and a stream curvature capable of producing a pitching-moment coefficient of -0.002 exist throughout the subsonic speed range. The slope parameters $dC_L/d\alpha$ and dC_m/dC_L were unaffected, however. No corrections for the effect of the stream irregularities were made to the data of the present investigation. At subsonic speeds the longitudinal variation of static pressure in the region of the model is not known accurately at present, but a preliminary survey has indicated that it is less than 2 percent of the dynamic pressure. No correction for this effect was made.

A survey of the air stream in the wind tunnel at supersonic speeds (reference 14) has shown a stream curvature only in the yaw plane of the model. The effects of this curvature on the measured characteristics of the present model are not known, but are believed to be small as judged by the results of reference 18. The survey of reference 14 also indicated that there is a static-pressure variation in the region of the model of sufficient magnitude to affect the drag results. A correction was added to the measured drag coefficients, therefore, to account for the longitudinal buoyancy caused by this static-pressure variation. This correction varied from as much as -0.0008 at a Mach number of 1.30 to 0.0009 at a Mach number of 1.70. No correction was made to the drag coefficients at a Mach number of 1.90, since the variation of the static pressure in the region of the model was not known.

Support interference.- At subsonic speeds, the effects of support interference on the aerodynamic characteristics of the model are not known. For the present tailless model, it is believed that such effects consisted primarily of a change in the pressure at the base of the model. In an effort to correct at least partially for this support interference, the base pressure was measured and the drag data were adjusted to correspond to a base pressure equal to the static pressure of the free stream.

At supersonic speeds, the effects of support interference on a body-sting configuration similar to that of the present model are shown by reference 19 to be confined to a change in base pressure. The previously mentioned adjustment of the drag for base pressure, therefore, was applied at supersonic speeds.

It should be noted that the drag coefficients presented are in essence foredrag coefficients, since the drag data do not include the effects of base drag (drag which a free-flight model would encounter).

RESULTS

The results are presented in this report without analysis in order to expedite publication. The variation of lift coefficient with angle of attack and the variation of pitching-moment coefficient, drag coefficient, and lift-drag ratio with lift coefficient at the various Reynold numbers and Mach numbers are shown in figure 2. The data presented in figure 2 are tabulated in tables II, III, and IV. The results of figure 2 for a Reynolds number of 4.9 million have been summarized in figure 3 to show the important parameters as functions of Mach number. The slope parameters in this figure have been measured at zero lift.

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National Advisory Committee for Aeronautics,
Moffett Field, Calif.

REFERENCES

1. Smith, Donald W., and Heitmeyer, John C.: Lift, Drag, and Pitching Moment of Low-Aspect-Ratio Wings at Subsonic and Supersonic Speeds - Plane Triangular Wing of Aspect Ratio 2 With NACA 0008-63 Section. NACA RM A50K20, 1951.

2. Smith, Donald W., and Heitmeyer, John C.: Lift, Drag, and Pitching Moment of Low-Aspect-Ratio Wings at Subsonic and Supersonic Speeds - Plane Triangular Wing of Aspect Ratio 2 With NACA 0005-63 Section. NACA RM A50K21, 1951.
3. Heitmeyer, John C., and Stephenson, Jack D.: Lift, Drag, and Pitching Moment of Low-Aspect-Ratio Wings at Subsonic and Supersonic Speeds - Plane Triangular Wing of Aspect Ratio 4 With NACA 0005-63 Section. NACA RM A50K24, 1951.
4. Phelps, E. Ray, and Smith, Willard G.: Lift, Drag, and Pitching Moment of Low-Aspect-Ratio Wings at Subsonic and Supersonic Speeds - Triangular Wing of Aspect Ratio 4 With NACA 0005-63 Thickness Distribution, Cambered and Twisted for Trapezoidal Span Load Distribution. NACA RM A50K24b, 1951.
5. Heitmeyer, John C., and Smith, Willard G.: Lift, Drag, and Pitching Moment of Low-Aspect-Ratio Wings at Subsonic and Supersonic Speeds - Plane Triangular Wing of Aspect Ratio 2 With NACA 0003-63 Section. NACA RM A50K24a, 1951.
6. Smith, Willard G., and Phelps, E. Ray: Lift, Drag, and Pitching Moment of Low-Aspect-Ratio Wings at Subsonic and Supersonic Speeds - Triangular Wing of Aspect Ratio 2 With NACA 0005-63 Thickness Distribution, Cambered and Twisted for a Trapezoidal Span Load Distribution. NACA RM A50K27a, 1951.
7. Reese, David E., and Phelps, E. Ray: Lift, Drag, and Pitching Moment of Low-Aspect-Ratio Wings at Subsonic and Supersonic Speeds - Plane Tapered Wing of Aspect Ratio 3.1 With 3-Percent-Thick, Biconvex Section. NACA RM A50K28, 1951.
8. Hall, Charles F., and Heitmeyer, John C.: Lift, Drag, and Pitching Moment of Low-Aspect-Ratio Wings at Subsonic and Supersonic Speeds - Twisted and Cambered Triangular Wing of Aspect Ratio 2 With NACA 0003-63 Thickness Distribution. NACA A51E01, 1951.
9. Heitmeyer, John C.: Lift, Drag, and Pitching Moment of Low-Aspect-Ratio Wings at Subsonic and Supersonic Speeds - Plane Triangular Wing of Aspect Ratio 4 With 3-Percent-Thick, Biconvex Section. NACA RM A51D30, 1951.
10. Heitmeyer, John C., and Hightower, Ronald C.: Lift, Drag, and Pitching Moment of Low-Aspect-Ratio Wings at Subsonic and Supersonic Speeds - Plane Triangular Wing of Aspect Ratio 4 With 3-Percent-Thick Rounded Nose Section. NACA RM A51F21, 1951.

11. Heitmeyer, John C.: Lift, Drag, and Pitching Moment of Low-Aspect-Ratio Wings at Subsonic and Supersonic Speeds - Plane Triangular Wing of Aspect Ratio 3 With NACA 0003-63 Section. NACA RM A51H02, 1951.
12. Heitmeyer, John C.: Lift, Drag, and Pitching Moment of Low-Aspect-Ratio Wings at Subsonic and Supersonic Speeds - Plane 45° Swept-Back Wing of Aspect Ratio 3, Taper Ratio 0.4 With 3-Percent-Thick, Biconvex Section. NACA RM A51H10, 1951.
13. Heitmeyer, John C.: Lift, Drag, and Pitching Moment of Low-Aspect-Ratio Wings at Subsonic and Supersonic Speeds - Body of Revolution. NACA RM A51H22, 1951.
14. Frick, Charles W., and Olson, Robert N.: Flow Studies in the Asymmetric Adjustable Nozzle of the Ames 6- by 6-Foot Supersonic Wind Tunnel. NACA RM A9E24, 1949.
15. Olson, Robert N., and Mead, Merrill H.: Aerodynamic Study of a Wing-Fuselage Combination Employing a Wing Swept Back 63° - Effectiveness of an Elevon on a Longitudinal Control and the Effects of Camber and Twist on the Maximum Lift-Drag Ratio at Supersonic Speeds. NACA RM A50A31a, 1950.
16. Glauert, H.: Wind-Tunnel Interference on Wings, Bodies and Airscrews. R.&M. No. 1566, British, A.R.C., 1933.
17. Herriot, John G.: Blockage Corrections for Three-Dimensional-Flow Closed-Throat Wind Tunnels, With Consideration of the Effect of Compressibility. NACA Rep. 995, 1950. (Formerly NACA RM A7B28)
18. Lessing, Henry C.: Aerodynamic Study of a Wing-Fuselage Combination Employing a Wing Swept Back 63° - Effect of Sideslip on Aerodynamic Characteristics at a Mach Number of 1.4 With the Wing Twisted and Cambered. NACA RM A50F09, 1950.
19. Perkins, Edward W.: Experimental Investigation of the Effects of Support Interference on the Drag of Bodies of Revolution at a Mach Number of 1.5. NACA TN 2292, 1951.

TABLE I.- COORDINATES IN INCHES OF THE APPROXIMATELY ELLIPTICAL SPAN LOAD, TWISTED AND CAMBERED, ASPECT RATIO 2 TRIANGULAR WING

[Location of stations measured in inches from plane of symmetry]

Station 0		Station 3.4				Station 6.8				Station 8.5			
X	Z	X _U	Z _U	X _L	Z _L	X _U	Z _U	X _L	Z _L	X _U	Z _U	X _L	Z _L
0	0	0	-0.142	0	-0.142	0	-0.284	0	-0.284	0	-0.355	0	-0.355
.425	.268	.303	.146	.361	-.279	.210	-.047	.283	-.361	.170	-.153	.240	-.412
.850	.370	.646	.263	.690	-.328	.461	.060	.533	-.378	.376	-.092	.450	-.413
1.700	.503	1.338	.400	1.353	-.406	.971	.207	1.031	-.396	.797	.084	.865	-.414
2.550	.595	2.025	.476	2.025	-.476	1.484	.302	1.530	-.411	1.222	.178	1.281	-.414
3.400	.663	2.706	.531	2.706	-.531	1.999	.370	2.031	-.425	1.649	.249	1.698	-.412
5.100	.737	4.080	.606	4.080	-.606	3.028	.455	3.038	-.454	2.505	.344	2.536	-.413
6.800	.813	5.440	.650	5.440	-.650	4.080	.488	4.080	-.488	3.362	.399	3.377	-.414
8.500	.842	6.800	.673	6.800	-.673	5.100	.505	5.100	-.505	4.218	.421	4.223	-.421
10.200	.850	8.160	.680	8.160	-.680	6.120	.510	6.120	-.510	5.100	.425	5.100	-.425
11.900	.843	9.520	.674	9.520	-.674	7.140	.506	7.140	-.506	5.950	.421	5.950	-.421
13.600	.822	10.880	.658	10.880	-.658	8.160	.493	8.160	-.493	6.800	.411	6.800	-.411
17.000	.750	13.600	.600	13.600	-.600	10.200	.450	10.200	-.450	8.500	.375	8.500	-.375
20.400	.647	16.320	.517	16.320	-.517	12.240	.388	12.240	-.388	10.200	.323	10.200	-.323
23.800	.519	19.040	.415	19.040	-.415	14.280	.311	14.280	-.311	11.900	.260	11.900	-.260
27.200	.372	21.760	.297	21.760	-.297	16.320	.223	16.320	-.223	13.600	.186	13.600	-.186
30.600	.205	24.480	.164	24.480	-.164	18.360	.123	18.360	-.123	15.300	.103	15.300	-.103
32.300	.114	25.840	.091	25.840	-.091	19.380	.069	19.380	-.069	16.150	.097	16.150	-.097
34.000	.018	27.200	.014	27.200	-.014	20.400	.011	20.400	-.011	17.000	.009	17.000	-.009
L.E. radius: 0.092		L.E. radius: 0.073				L.E. radius: 0.055				L.E. radius: 0.046			

Station 10.2				Station 11.9				Station 13.6				Station 15.3			
X _U	Z _U	X _L	Z _L	X _U	Z _U	X _L	Z _L	X _U	Z _U	X _L	Z _L	X _U	Z _U	X _L	Z _L
0	-0.426	0	-0.426	0	-0.497	0	-0.497	0	-0.568	0	-0.568	0	-0.654	0	-0.654
.133	-.259	.194	-.465	.096	-.372	.150	-.524	.061	-.483	.103	-.582	.028	-.609	.054	-.657
.294	-.174	.364	-.462	.217	-.298	.276	-.513	.141	-.429	.187	-.571	.067	-.581	.097	-.650
.628	-.051	.698	-.448	.463	-.196	.528	-.492	.304	-.354	.356	-.549	.149	-.541	.183	-.637
.966	.039	1.031	-.433	.715	-.118	.778	-.470	.470	-.291	.524	-.524	.231	-.496	.265	-.611
1.306	.106	1.363	-.421	-	-	-	-	.638	-.241	.691	-.502	.483	-.415	.519	-.564
1.968	.208	2.033	-.396	1.483	-.036	1.535	-.416	.976	-.161	1.026	-.461	.692	-.371	.687	-.532
2.672	.272	2.704	-.378	1.990	.103	2.033	-.383	1.316	-.102	1.361	-.425	.822	-.334	.855	-.501
3.357	.310	3.378	-.362	2.503	.152	2.537	-.353	1.658	-.092	1.697	-.387	.992	-.297	1.022	-.467
4.041	.332	4.054	-.349	3.015	.188	3.043	-.322	1.999	-.012	2.033	-.351	1.164	-.273	1.191	-.437
4.726	.342	4.732	-.337	3.529	.207	3.549	-.299	2.342	.017	2.370	-.321	1.335	-.249	1.360	-.414
5.411	.332	5.411	-.326	4.043	.217	4.058	-.276	2.684	.039	2.709	-.291	1.679	-.212	1.698	-.362
6.800	.300	6.800	-.300	5.069	.218	5.076	-.232	3.370	.069	3.386	-.231	2.023	-.181	2.037	-.311
8.160	.259	8.160	-.259	6.120	.194	6.120	-.194	4.056	.079	4.066	-.176	2.367	-.159	2.377	-.263
9.520	.208	9.520	-.208	7.140	.156	7.140	-.156	4.741	.078	4.747	-.130	2.711	-.139	2.717	-.214
10.880	.149	10.880	-.149	8.160	.112	8.160	-.112	5.387	.063	5.390	-.086	3.056	-.132	3.059	-.173
12.240	.082	12.240	-.080	9.180	.062	9.180	-.062	6.113	.042	6.114	-.071	3.228	-.129	3.229	-.152
12.920	.046	12.920	-.046	9.690	.034	9.691	-.034	6.457	.021	6.457	-.023	3.400	-.124	3.400	-.128
13.600	.007	13.600	-.007	10.200	.005	10.200	-.005	6.800	.005	6.800	-.005	-	-	-	-
L.E. radius: 0.037				L.E. radius: 0.028				L.E. radius: 0.018				L.E. radius: 0.009			
Station 17.0 X = 0 Y = -0.710															

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TABLE II.- AERODYNAMIC CHARACTERISTICS OF THE MODEL
AT A REYNOLDS NUMBER OF 3.0 MILLION

M	α	C_L	C_D	C_m	M	α	C_L	C_D	C_m
0.6	-0.53	-0.057	0.0113	0.010	1.53	-0.49	-0.048	0.0193	0.015
	-1.08	-.082	.0131	.014		-1.02	-.070	.0199	.020
	-2.17	-.136	.0178	.023		-2.06	-.115	.0234	.032
	-3.24	-.185	.0239	.030		-3.09	-.158	.0284	.043
	-4.32	-.238	.0312	.038		-4.12	-.200	.0347	.053
	-6.47	-.340	.0510	.052		-6.19	-.282	.0512	.073
	.54	-.010	.0097	.004		.50	-.002	.0164	.003
	1.02	.013	.0090	0		1.02	.017	.0161	-.001
	2.10	.060	.0087	-.006		2.01	.060	.0167	-.013
	3.12	.104	.0092	-.012		3.06	.104	.0187	-.024
	4.19	.150	.0111	-.019		4.09	.146	.0219	-.036
	6.33	.240	.0204	-.031		6.15	.229	.0327	-.056
	8.46	.329	.0311	-.044		8.22	.310	.0494	-.076
	10.60	.425	.0488	-.058		10.28	.391	.0722	-.096
	12.75	.531	.0809	-.074		12.35	.471	.1010	-.115
	14.93	.658	.1373	-.092		14.40	.539	.1341	-.132
	17.11	.776	.1996	-.106		16.47	.612	.1734	-.149
	19.28	.885	.2660	-.115		18.54	.679	.2167	-.164
						20.61	.746	.2672	-.176
						22.69	.811	.3236	-.186
0.8	-.55	-.063	.0120	.013	1.70	-.48	-.042	.0188	.013
	-1.10	-.089	.0139	.017		-1.01	-.062	.0196	.018
	-2.20	-.145	.0190	.027		-2.05	-.102	.0228	.028
	-3.29	-.203	.0263	.037		-3.08	-.141	.0270	.037
	-4.37	-.258	.0348	.047		-4.11	-.179	.0326	.046
	-6.55	-.373	.0574	.066		-6.16	-.253	.0474	.064
	.54	-.009	.0104	.003		.50	-.002	.0163	.003
	1.03	.016	.0094	0		1.02	.014	.0161	-.001
	2.06	.065	.0092	-.008		2.00	.054	.0168	-.011
	3.16	.116	.0100	-.016		3.05	.093	.0189	-.021
	4.23	.165	.0130	-.024		4.08	.132	.0219	-.031
	6.38	.262	.0233	-.039		6.13	.209	.0320	-.050
	8.53	.358	.0364	-.053		8.19	.283	.0474	-.068
	10.70	.468	.0616	-.070		10.25	.355	.0679	-.086
	12.89	.576	.1103	-.081		12.31	.427	.0937	-.103
						14.36	.491	.1237	-.118
						16.42	.557	.1598	-.132
						18.48	.623	.2009	-.144
						20.55	.685	.2479	-.155
						22.62	.748	.3012	-.165
0.9	-.56	-.063	.0129	.013	1.90	-.48	-.040	.0235	.011
	-1.12	-.093	.0145	.019		-1.00	-.057	.0237	.016
	-2.21	-.153	.0198	.031		-2.04	-.093	.0260	.024
	-3.31	-.213	.0275	.044		-3.07	-.128	.0294	.032
	-4.41	-.279	.0379	.058		-4.09	-.162	.0341	.040
	-6.59	-.396	.0621	.081		-6.14	-.228	.0471	.056
	.54	-.008	.0094	.003		.55	-.005	.0180	.003
	1.03	.019	.0088	-.001		1.01	.012	.0179	-.001
	2.08	.072	.0093	-.010		2.00	.047	.0184	-.009
	3.17	.121	.0103	-.018		3.04	.083	.0199	-.018
	4.25	.174	.0133	-.027		4.06	.117	.0227	-.026
	6.42	.280	.0245	-.045		6.12	.187	.0319	-.043
	8.61	.397	.0465	-.070		8.17	.252	.0457	-.058
						10.22	.317	.0640	-.073
						12.27	.381	.0869	-.087
						14.33	.449	.1156	-.100
						16.38	.501	.1464	-.110
						18.44	.560	.1841	-.120
						20.50	.620	.2275	-.130
						22.57	.678	.2757	-.141
						24.63	.737	.3303	-.152
1.30	-.50	-.066	.0154	.023					
	-1.03	-.091	.0178	.030					
	-2.06	-.140	.0225	.043					
	-3.09	-.188	.0286	.055					
	-4.13	-.235	.0363	.067					
	-6.19	-.330	.0557	.092					
	.54	-.018	.0161	.010					
	1.01	.006	.0157	.004					
	2.00	.054	.0160	-.008					
	3.05	.099	.0176	-.020					
	4.08	.146	.0206	-.033					
	6.15	.241	.0315	-.058					
	8.21	.332	.0492	-.082					
	10.27	.427	.0765	-.106					
	12.34	.517	.1083	-.130					
	14.40	.605	.1437	-.153					



TABLE III.- AERODYNAMIC CHARACTERISTICS OF THE MODEL
AT A REYNOLDS NUMBER OF 4.9 MILLION

M	α	C_L	C_D	C_m	M	α	C_L	C_D	C_m
0.6	-0.58	-0.065	0.0123	0.013	1.30	4.17	0.152	0.0208	-0.034
	-1.13	-.091	.0140	.017		6.28	.248	.0319	-.059
	-2.22	-.142	.0185	.024		8.38	.337	.0497	-.083
	-3.31	-.194	.0243	.032		10.49	.428	.0763	-.107
	-4.41	-.245	.0317	.039		12.61	.521	.1095	-.131
	-6.60	-.352	.0525	.054		14.73	.612	.1502	-.154
	.53	-.012	.0103	.004					
	1.03	.014	.0094	0	1.53	-5.3	-.048	.0175	.015
	2.14	.062	.0089	-.006		-1.06	-.070	.0190	.020
	3.17	.110	.0096	-.013		-2.11	-.114	.0227	.032
	4.25	.154	.1149	-.019		-3.17	-.156	.0276	.042
	6.41	.243	.0204	-.032		-4.22	-.199	.0340	.053
	8.57	.332	.0311	-.044		-6.32	-.278	.0505	.073
	10.74	.430	.0497	-.059		.49	-.003	.0160	.003
	12.92	.529	.0804	-.074		.98	.018	.0158	-.002
	15.15	.655	.1347	-.093		2.06	.060	.0166	-.013
	17.39	.781	.2026	-.107		3.11	.105	.0185	-.025
0.8	19.60	.888	.2707	-.116		4.16	.148	.0219	-.036
						6.27	.233	.0328	-.057
	-1.16	-.069	.0128	.015		8.37	.309	.0491	-.076
	-2.27	-.151	.0196	.019		10.47	.387	.0718	-.095
	-3.37	-.205	.0259	.029		12.57	.465	.1006	-.115
	-4.49	-.264	.0348	.038		14.68	.544	.1324	-.133
	-6.72	-.379	.0581	.047		16.79	.617	.1727	-.149
	.53	-.011	.0103	.066	1.70	-5.2	-.042	.0167	.013
	1.04	.016	.0096	0		-1.05	-.063	.0179	.018
	2.12	.069	.0091	-.008		-2.10	-.103	.0212	.028
	3.21	.119	.0100	-.017		-3.15	-.142	.0258	.037
	4.31	.168	.0125	-.025		-4.20	-.180	.0314	.046
	6.50	.265	.0221	-.039		-6.30	-.256	.0470	.063
	8.70	.363	.0352	-.054		.50	-.002	.0157	.002
	10.91	.468	.0611	-.070		1.04	.017	.0155	-.001
	13.13	.569	.1084	-.082		2.05	.057	.0162	-.012
	15.37	.694	.1672	-.110		3.11	.097	.0181	-.022
	17.60	.807	.2298	-.133		4.16	.137	.0213	-.032
0.9						6.26	.214	.0317	-.051
	-1.17	-.100	.0148	.016	1.90	8.35	.284	.0469	-.069
	-2.29	-.158	.0200	.022		10.44	.358	.0679	-.086
	-3.41	-.216	.0271	.033		12.54	.427	.0935	-.103
	-4.54	-.279	.0370	.044		14.64	.498	.1261	-.119
	-6.79	-.405	.0635	.057		16.75	.567	.1629	-.133
	.53	-.011	.0106	.082					
	1.05	.018	.0096	0		-5.2	-.041	.0176	.012
	2.13	.075	.0093	-.011		-1.05	-.059	.0185	.016
	3.24	.126	.0104	-.020		-2.09	-.095	.0215	.024
	4.34	.178	.0131	-.029		-3.14	-.129	.0254	.033
	6.56	.286	.0239	-.047		-4.18	-.163	.0307	.040
1.30	8.79	.399	.0447	-.069		-6.27	-.231	.0446	.056
	11.05	.522	.0806	-.096		.49	-.004	.0164	.003
						1.03	.013	.0162	-.001
	-1.07	-.070	.0187	.025		2.04	.048	.0169	-.009
	-2.13	-.144	.0244	.031		3.09	.084	.0187	-.018
	-3.19	-.192	.0302	.044		4.13	.120	.0216	-.027
	-4.24	-.240	.0376	.057		6.22	.189	.0310	-.043
	-6.35	-.332	.0566	.069		8.31	.257	.0454	-.059
	.53	-.019	.0164	.093		10.39	.319	.0634	-.073
	1.02	.007	.0159	.011		12.48	.382	.0863	-.087
	2.05	.056	.0160	.004		14.57	.443	.1138	-.099
	3.11	.103	.0176	-.008		16.68	.506	.1484	-.110
				-.021		18.79	.572	.1889	-.121



TABLE IV.- AERODYNAMIC CHARACTERISTICS OF THE MODEL
AT A REYNOLDS NUMBER OF 7.5 MILLION

M	α	C_L	C_D	C_m	M	α	C_L	C_D	C_m
0.6	-0.62	-0.065	0.0123	0.013	1.30	-0.59	-0.071	0.0180	0.025
	-1.17	-.091	.0141	.017		-1.14	-.097	.0198	.032
	-2.29	-.143	.0185	.025		-2.24	-.147	.0243	.045
	-3.41	-.196	.0246	.032		-3.33	-.195	.0303	.058
	-4.54	-.252	.0326	.040		-4.42	-.242	.0380	.070
	-6.78	-.357	.0537	.054		-6.61	-.338	.0587	.095
	.52	-.015	.0102	.005		.51	-.020	.0160	.011
	1.04	.013	.0094	0		1.05	.005	.0156	.005
	2.18	.062	.0092	-.006		2.10	.056	.0158	-.008
	3.22	.108	.0100	-.013		3.20	.105	.0175	-.022
	4.33	.156	.0118	-.020		4.29	.152	.0207	-.034
	6.53	.246	.0207	-.033		6.47	.248	.0319	-.060
	8.74	.336	.0317	-.045		8.66	.343	.0505	-.085
	10.95	.431	.0510	-.059		9.64	.386	.0624	-.096
	13.19	.538	.0850	-.076	1.53	-.57	-.050	.0174	.015
0.8	15.48	.659	.1388	-.092		-1.11	-.073	.0191	.021
	-.64	-.070	.0129	.015		-2.20	-.118	.0228	.032
	-1.21	-.098	.0147	.019		-3.29	-.160	.0276	.043
	-2.36	-.155	.0197	.029		-4.37	-.210	.0359	.056
	-3.50	-.213	.0267	.039		-6.55	-.285	.0519	.075
	-4.65	-.270	.0357	.048		.49	-.005	.0161	.003
	-6.94	-.383	.0596	.067		1.01	.018	.0159	-.002
	.52	-.013	.0104	.005		2.11	.062	.0165	-.013
	1.05	.014	.0096	0		3.20	.106	.0186	-.025
	2.15	.068	.0094	-.008		-4.29	.150	.0221	-.036
	3.29	.121	.0104	-.017		6.45	.233	.0334	-.058
	4.41	.169	.0127	-.025		8.62	.316	.0510	-.078
	6.66	.268	.0224	-.040		10.04	.370	.0659	-.091
	8.91	.367	.0362	-.055	1.70	-.55	-.043	.0168	.013
	11.20	.478	.0654	-.071		-1.10	-.067	.0182	.019
	12.39	.549	.0940	-.083		-2.17	-.106	.0216	.029
0.9	-.62	-.062	.0126	.015		-3.25	-.146	.0263	.038
	-1.21	-.095	.0147	.021		-4.32	-.183	.0321	.047
	-2.38	-.160	.0203	.033		-6.47	-.257	.0478	.066
	-3.56	-.228	.0286	.046		.49	-.003	.0158	.003
	-4.68	-.274	.0370	.056		1.06	.016	.0157	-.001
	-7.04	-.418	.0668	.085		2.09	.057	.0164	-.012
	.52	-.011	.0101	.005		3.17	.097	.0184	-.022
	1.06	.017	.0093	0		4.24	.137	.0217	-.032
	2.18	.076	.0093	-.011		6.39	.213	.0323	-.051
	3.32	.129	.0106	-.020		8.54	.287	.0483	-.069
	4.46	.182	.0136	-.029		10.69	.360	.0699	-.087
	6.73	.286	.0239	-.047		11.39	.385	.0783	-.092
	9.04	.402	.0461	-.068					

Equation of fuselage radii:

$$\frac{r}{r_0} = \left[1 - \left(1 - \frac{2x}{l} \right)^2 \right]^{3/4}$$

All dimensions shown in inches

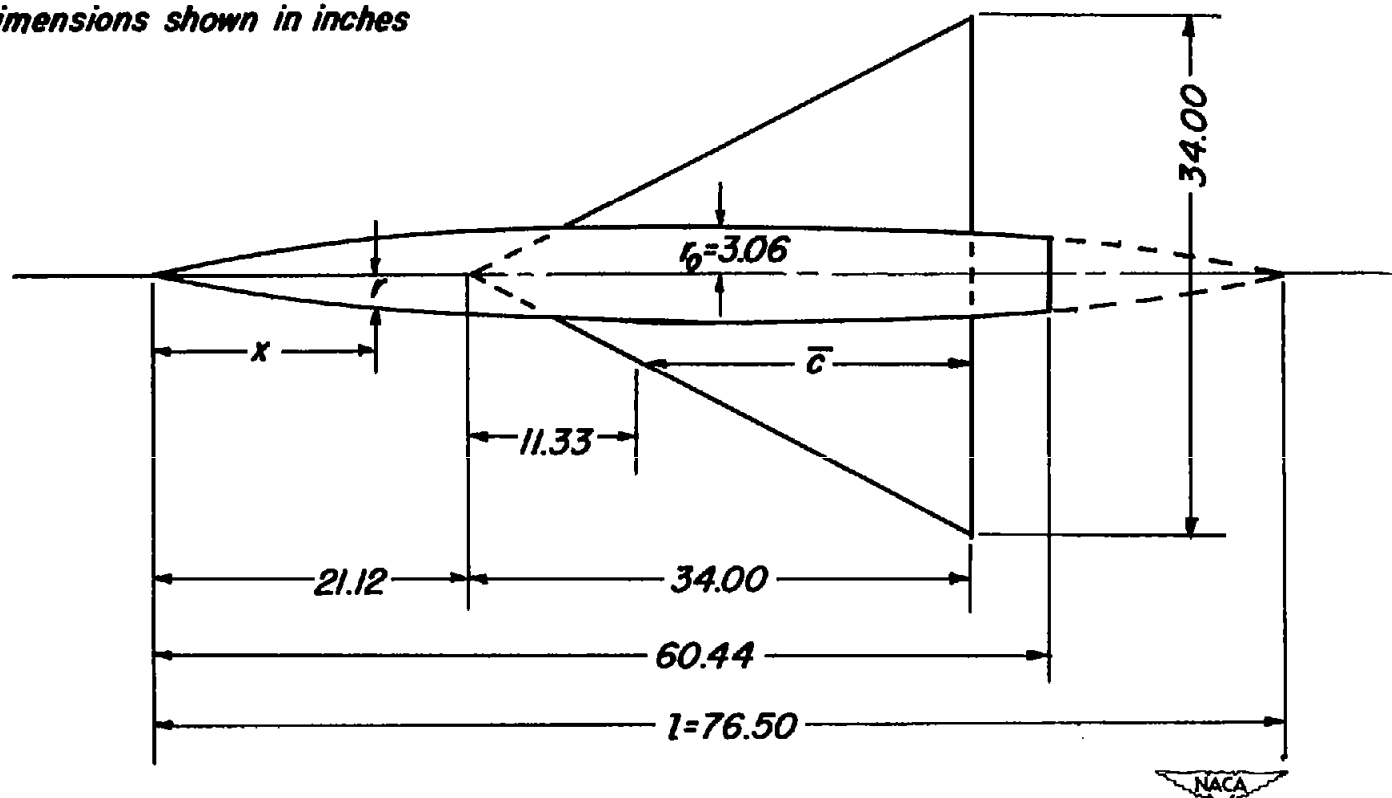


Figure 1.- Plan view of the model.

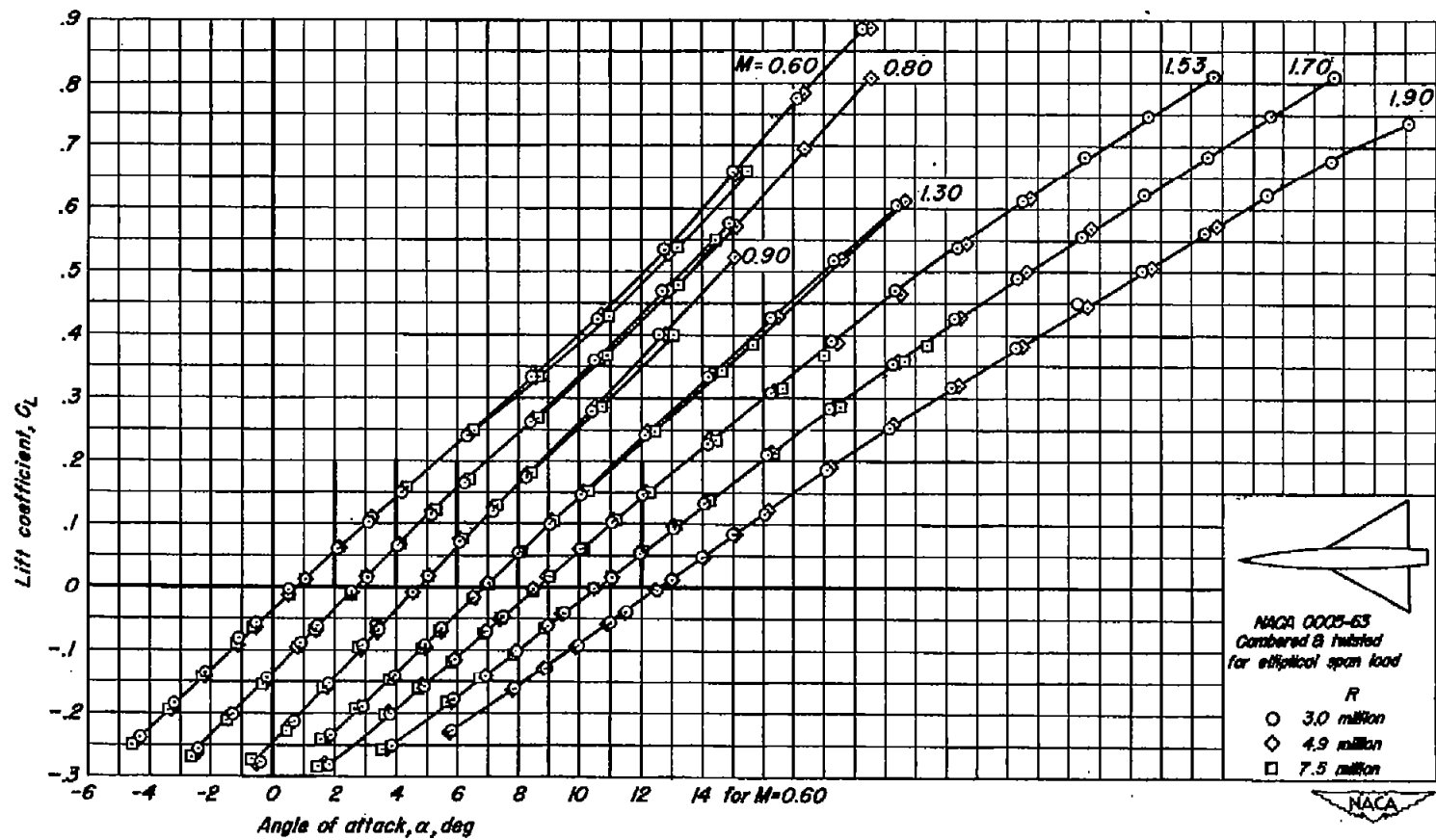


Figure 2.- The variation of the aerodynamic characteristics with lift coefficient at various Mach numbers.

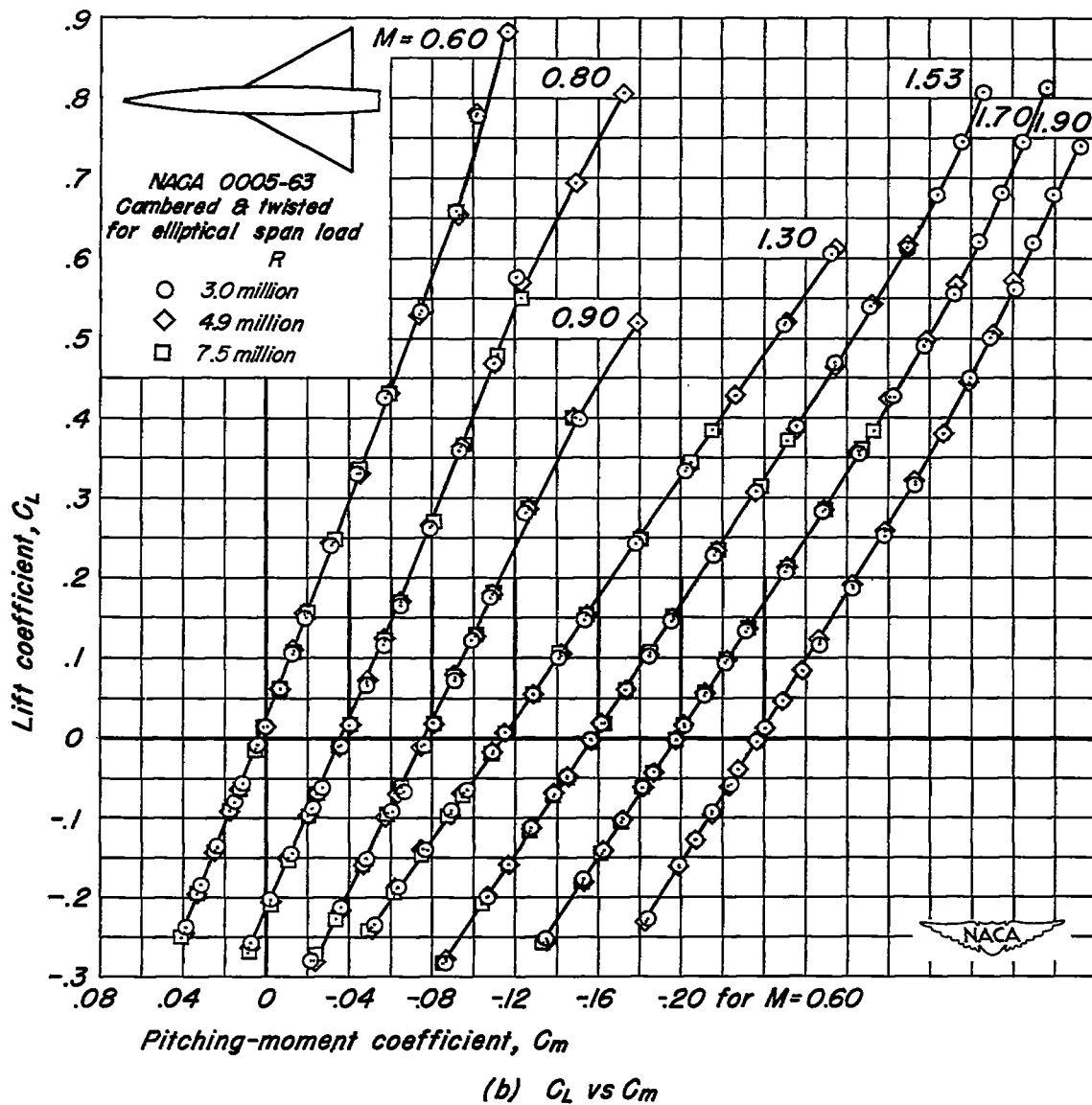
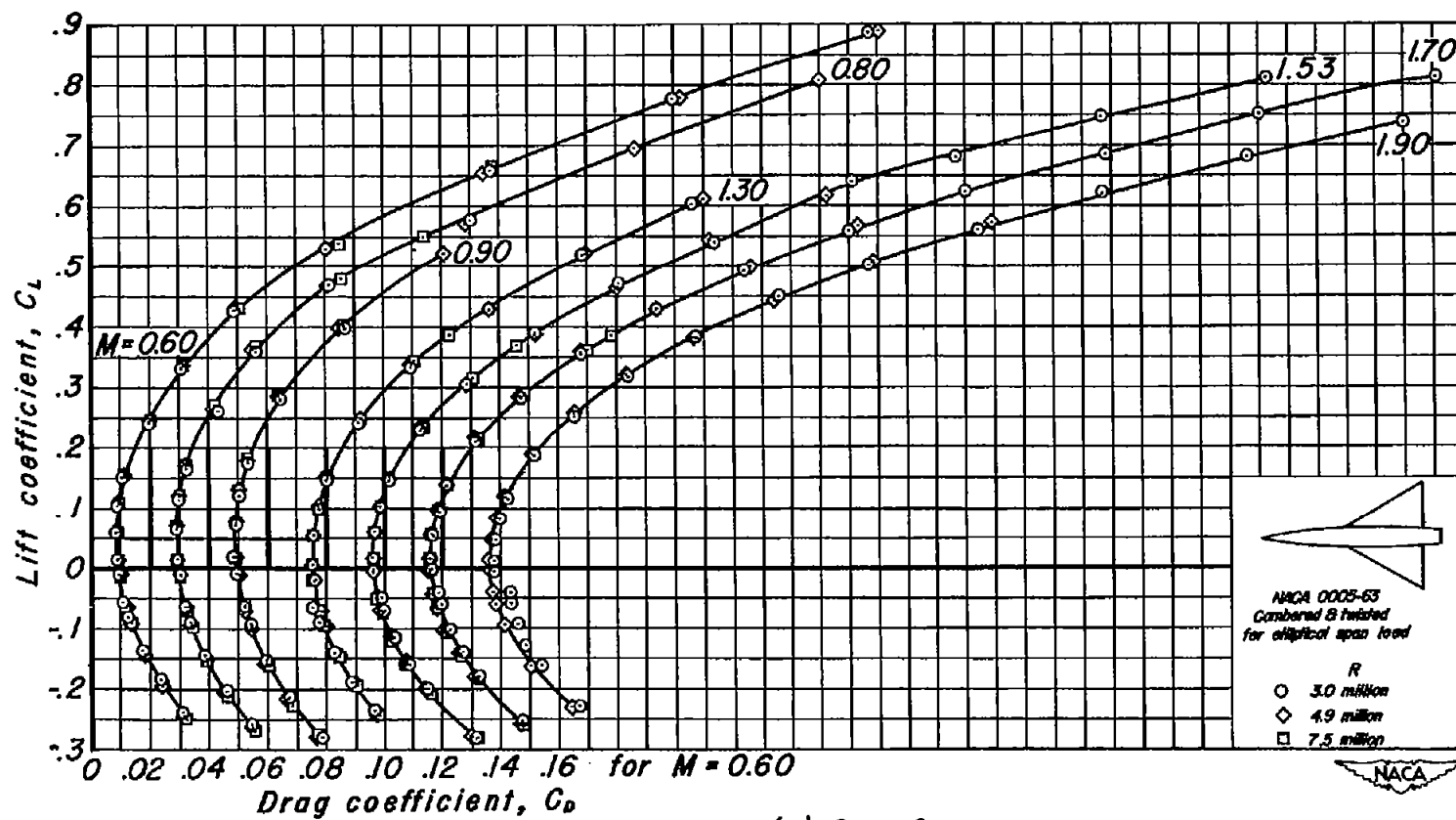


Figure 2.-Continued



(c) C_L vs C_D
Figure 2 - Continued.

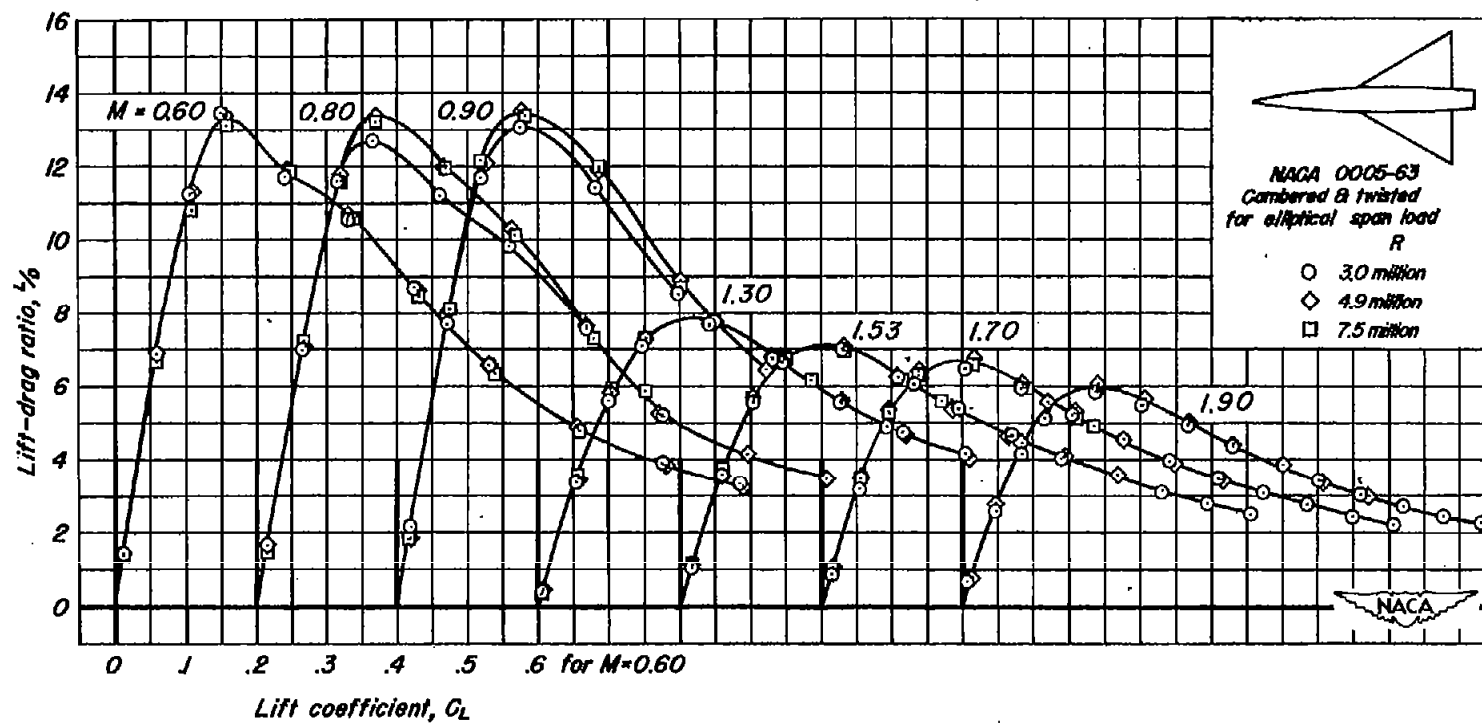
(d) $\frac{L}{D}$ vs C_L

Figure 2.-Concluded.

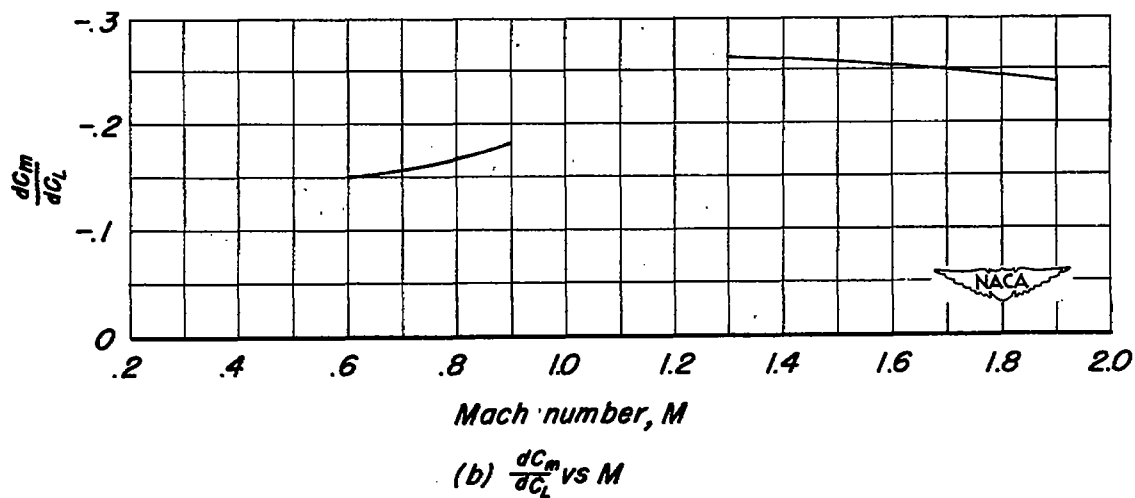
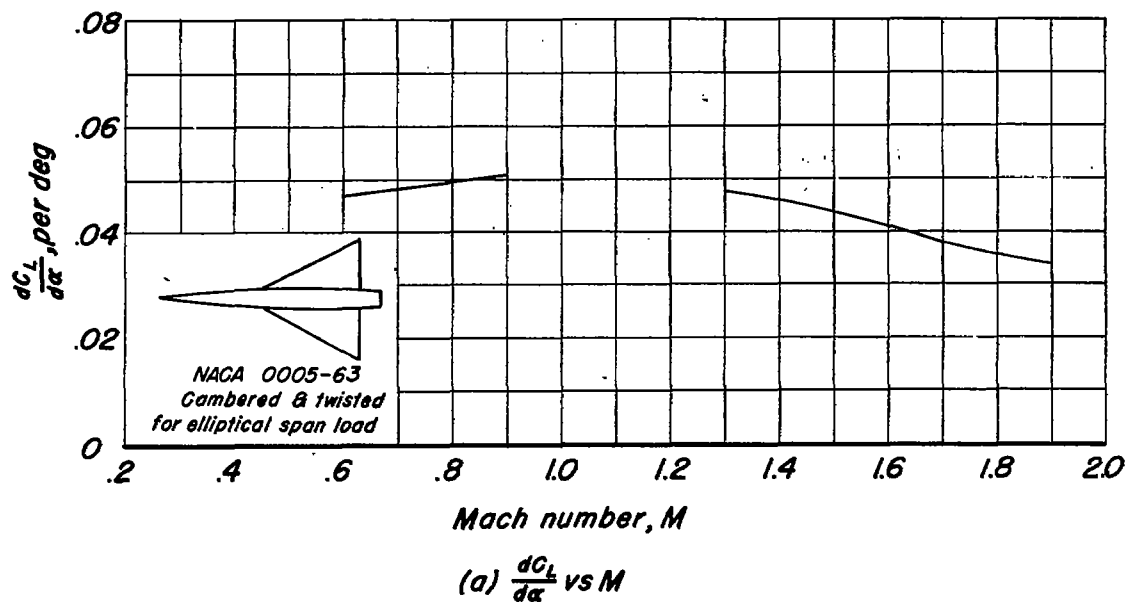


Figure 3.—Summary of aerodynamic characteristics as a function of Mach number. Reynolds number, 4.9 million.

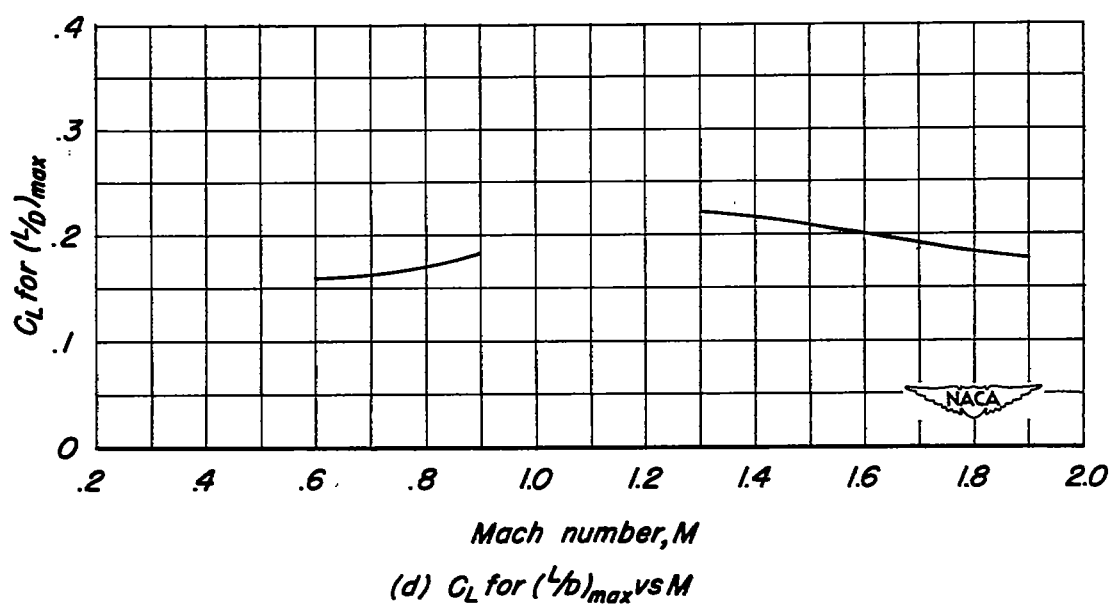
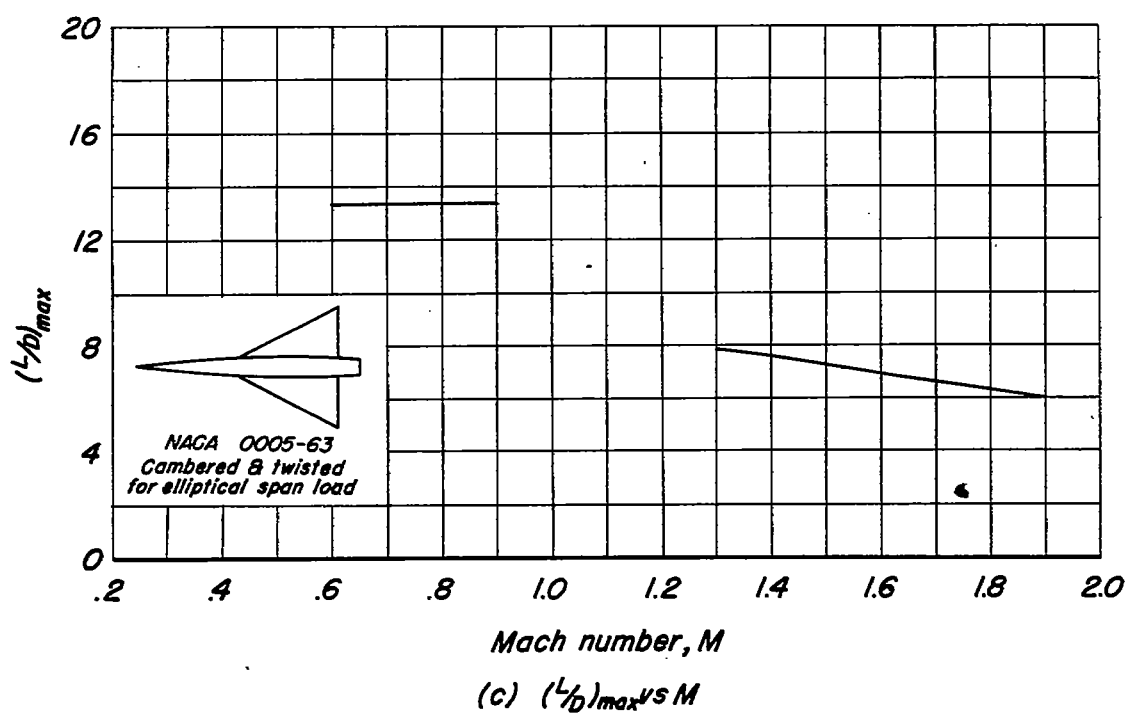
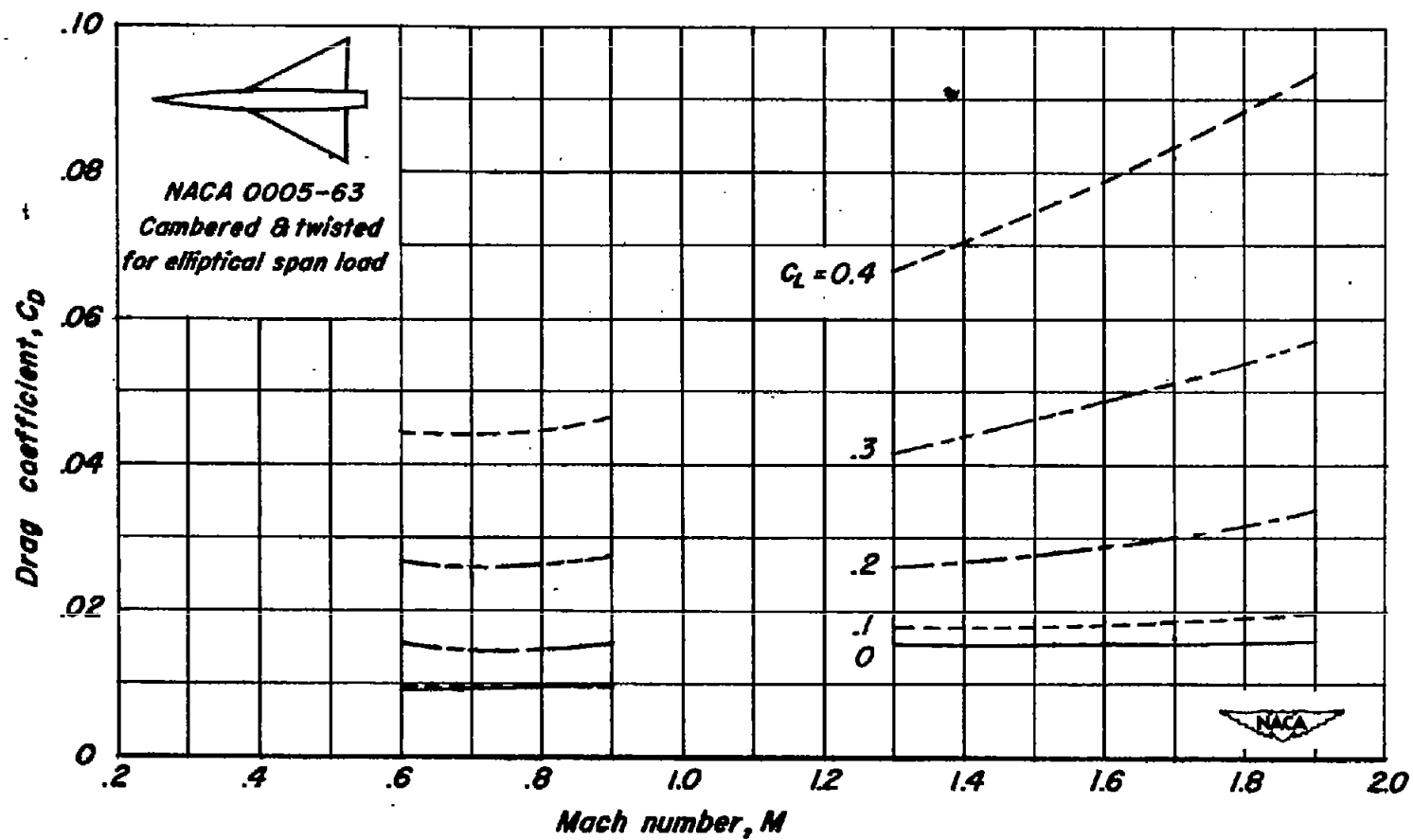


Figure 3.-Continued.



(e) C_D vs M
Figure 3.—Concluded.